Contents

textsc

Preface

深度学习

Summary

1.1　测试

　　我的第一个结果，是博士第一年的暑假开始做的，其实我是很幸运的，当时国内有位老师在我老板这里访问，这位老师非常热心并且耐心地教了我很多细节性的东西，让我能够快速上手做问题。很多细节性的东西，往往是需要对一个领域非常熟稔之后才能体悟到的，对于一个低年级的 Phd 来说，这时有人带着的话比自己看论文去学是省不少时间的，我真的很感激！

　　控制多图行距, 临时改变行距.

　　那个暑假我们做出了一个我们觉着很漂亮的结果，然后我就开始动手写了。写的过程，花费了很大的精力，毕竟是自己读 Phd 之后第一篇正儿八经的文章，中间就来来回回地思考怎么合理地安排证明结构，让证明能非常简洁漂亮，包括中间不断地修正证明里面的各种小漏洞。

　　因为我当时刚第二年，课业的压力还不小，博士是要求学一些本专业不是你研究方向的课，但因为我本科时并没有多少计算机基础，所以我上那些需要编程之类的课还是很耗精力的。加上当时我还做着助教，所以几乎都是挤时间在敲论文。

　　当时有一天夜里兴致来了，一直敲到三四点，把里面最关键的一个引理，11 页的证明敲完了。我当时从系里往家走的时候，外面下着雪，还不小，可当时的我漫步雪中，觉着这雪飘得好温柔啊，一切都是那么的宁静和美好。回到家后，久久不能入睡，我忍不住发了下面这么一条朋友圈。那

A

(a) A subfigure

B

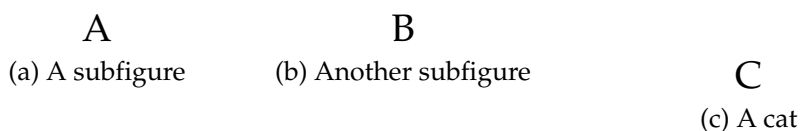(b) Another subfigure

C

(c) A cat

图 1.1 A figure

时的我，所感受到的是一种科研带来的发自内心深处的愉悦感和充实感。

这篇文章前前后后写了有半年，中间还因为准备 qual exam（博士生资格考试）耽搁了一两个月，到了 17 年二月份的时候，差不多写好就准备投了。我老板也是非常负责上心，整篇文章，接近 60 页的证明，老板一步步地检查，给我写了密密麻麻的修改意见，从证明结构到单词语法，我其实挺感动的。

我觉着自己的博士生涯算是有了个不错的开端，希望自己能一直这样努力保持下去，最终收获一个还不错的结果。

那时的我不单单对学术，对自己的生活也是充满了憧憬与热爱。我办公室里养了很多花，我很细心地照料着她们，其中我最喜欢的是一盆兰花，"兰生幽谷，不以无人而不芳。"不是"孤芳自赏"之意，只是用于勉励自己在略显孤寂的博士生涯中能在各方面都努力提升自己。

First chapter

Summary

This first chapter illustrates how to use various elements of this text book template, such as definitions, theorems and exercises. You may want to start each chapter with a meta summary like this one, to explain to the reader what the chapter is all about, why it is important and how it fits into the bigger picture of the book. Another useful tip is to put the contents of each chapter into a separate LaTeX file and then use the command \input{} to include the chapter in the main document.

2.1   First section

Wo are 1234774567 1234567 Let's start out with the following theorem.

> **Theorem 2.1 (Logic algebra)** Let P, Q and R be logical propositions (true or false). Then the following propositions are true:
>
> $$P \wedge Q \Leftrightarrow Q \wedge P \qquad\qquad P \vee Q \Leftrightarrow Q \vee P \qquad\qquad \text{(commutative laws)}$$
> $$(P \wedge Q) \wedge R \Leftrightarrow P \wedge (Q \wedge R) \qquad (P \vee Q) \vee R \Leftrightarrow P \vee (Q \vee R) \qquad \text{(associative laws)}$$
> $$P \wedge (Q \vee R) \Leftrightarrow (P \wedge Q) \vee (P \wedge R) \quad P \vee (Q \wedge R) \Leftrightarrow (P \vee Q) \wedge (P \vee R) \quad \text{(distributive laws)}$$
> $$\neg(P \wedge Q) \Leftrightarrow \neg P \vee \neg Q \qquad\qquad \neg(P \vee Q) \Leftrightarrow \neg P \wedge \neg Q \qquad \text{(De Morgan's laws)}$$

Proof. We prove the first of De Morgan's laws and leave the proofs of the remaining propositions as exercises. To prove the statement, we create a truth table and fill in all possible values (true or false) for the propositions P and Q. Each of these propositions can be either true or false and we thus obtain the following truth table with four cases:

¬	(P	∧	Q)	⇔	¬	P	∨	¬	Q
	T		T			T			T
	T		F			T			F
	F		T			F			T
	F		F			F			F

By definition of the logical operators, we compete the table to obtain

¬	(P	∧	Q)	⇔	¬	P	∨	¬	Q
F	T	T	T	**T**	F	T	F	F	T
T	T	F	F	**T**	F	T	T	T	F
T	F	F	T	**T**	T	F	T	F	T
T	F	F	F	**T**	T	F	T	T	F

It follows that the statement we want to prove (the equivalence ⇔) is al-
ways true (a *tautology*), which proves the statement.   □

2.2   Second section

We begin our next section with the following central definition.

> **Definition   2.1   (Rational Cauchy sequence)** A rational Cauchy se-
> quence is a rational sequence $(x_n)_{n=0}^{\infty}$ such that
>
> $$\forall \epsilon \in \mathbb{Q}_+ \ \exists N \in \mathbb{N} : m, n \geq N \Rightarrow |x_m - x_n| < \epsilon. \tag{2.1}$$
>
> In other words, for each (small) rational number $\epsilon > 0$ there is a (big)
> number N such that the distance $|x_m - x_n|$ between x_m and x_n is less
> than ϵ if both m and n are larger than or equal to N.

A remark may be in order here. This definition is concerned with rational
Cauchy sequences. We will later encounter a similar definition of real *Cauchy
sequences.*

Exempel   2.1   (Solving the equation $x^2 = 2$) Consider the equation
$x^2 = 2$. It is easy to prove that this equation does not have any ratio-
nal solutions. However, consider the following iteration formula:

$$x_n = \frac{x_{n-1} + 2/x_{n-1}}{2}, \tag{2.2}$$

where $n = 1, 2, 3, \ldots$ and $x_0 = 1$. The resulting sequence of rational numbers quickly approaches a number in the vicinity of $x = 1.4142135623731$:

$$
\begin{aligned}
x_0 &= 1 \\
x_1 &= (x_0 + 2/x_0)/2 &=& \ 1.5 \\
x_2 &= (x_1 + 2/x_1)/2 &\approx& \ 1.4166666666667 \\
x_3 &= (x_2 + 2/x_2)/2 &\approx& \ 1.4142156862745 \\
x_4 &= (x_3 + 2/x_3)/2 &\approx& \ 1.4142135623747 \\
x_5 &= (x_4 + 2/x_4)/2 &\approx& \ 1.4142135623731 \\
x_6 &= (x_5 + 2/x_5)/2 &\approx& \ 1.4142135623731 \\
x_7 &= (x_6 + 2/x_6)/2 &\approx& \ 1.4142135623731 \\
x_8 &= (x_7 + 2/x_7)/2 &\approx& \ 1.4142135623731 \\
x_9 &= (x_8 + 2/x_8)/2 &\approx& \ 1.4142135623731 \\
x_{10} &= (x_9 + 2/x_9)/2 &\approx& \ 1.4142135623731
\end{aligned}
$$

We will later see that this iteration, or any other equivalent iteration, defines the real number $\sqrt{2}$.

2.3   Long Long Long Long Long Title

Now let's move on to the definition of the real number system. This may be defined in a multitude of ways, one of which is to think about a real number as a rational Cauchy sequence, or rather the equivalence class of Cauchy sequences "converging to" that number.

> **Definition 2.2 (The real numbers $\mathbb{R}$)** The real numbers $\mathbb{R}$ is the set of all equivalence classes of rational Cauchy sequences.

Now that this is settled, lets prove the completeness of the real number system.

> **Theorem 2.2 (The completeness of the real numbers)** Let $(x_n)_{n=0}^{\infty}$ be a sequence of real numbers. Then $(x_n)_{n=0}^{\infty}$ is convergent if and only if it is also a real Cauchy sequence.

Proof. Write $x_m = [(x_{mn})_{n=0}^{\infty}]$ where x_{mn} is the nth number in a rational Cauchy sequence representing the real number x_m. And so on.…   □

For further reading, there are several excellent works that one could cite, such as (**Tao2006**; **Turing1936**).

Exercises

Exercise 2.1 Let $A = \{1, 2, 3\}$ and $B = \{2, 3, 4\}$. Determine the following sets.
(a) $A \cup B$ (b) $A \cap B$ (c) $A \setminus B$ (d) $A \times B$

Exercise 2.2 Let $A = \{1, 3, 5, 7, 9\}$ and $B = \{2, 4, 6, 8, 10\}$. Determine the following sets.
(a) $A \cup B$ (b) $A \cap B$ (c) $A \setminus B$ (d) $A \times B$

Exercise 2.3 Let $A = \{1, 2, 3\}$, $B = \{2, 3, 4\}$ and $C = \{3, 4, 5\}$. Determine the following sets.
(a) $A \cup B \cup C$ (b) $A \cap B \cap C$ (c) $(B \setminus A) \cap C$ (d) $(A \times B) \times C$

Problem

Problem 2.1 Interpret the following set definition (Russell's paradox) and discuss whether $X \in X$ or $X \notin X$:

$$X = \{x \mid x \notin x\}. \tag{2.3}$$

Computer exercises

Computer exercise 2.1 Write a program that generates the sequence $(x_n)_{n=0}^{100}$ for $x_n = n$.

Computer exercise 2.2 Write a program that generates the odd numbers between 1 and 100.

Computer exercise 2.3 Write a program that computes the sum $\sum_{n=0}^{100} x_n$ for $x_n = n$.

Linear Equations in 3
Linear Algebra

Summary

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3.1 First section

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4 Third chapter

Summary

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